Claims

Claim 1: A preform cooler comprising (a) preform carriers which are provided with cylindrical protrusions to receive bottomed cylindrical preforms taken out of a mold for injection molding while placing them over the cylindrical protrusions, (b) a carrier driving means which drives the preform carriers to move the cylindrical protrusions from a preform supply area to a delivery area and then to the supply area again along a preform transfer route, and (c) an air diffusing means for cooling the inner walls of the preforms, which is used to send cooling air upward via an airflow path to the insides of the cylindrical protrusions moving along the preform transfer route, wherein each of the preform carriers is provided with the cylinderical protrusions in the same number as that of cavities in the mold and each of the cylindrical protrusions is provided with a plurarity of air diffusing holes to diffuse cooling air sent to that cylindrical protrusion to the inside of each preform.

Claim 2: A preform cooler as claimed in claim 1, wherein (a) the preform transfer route is structured like a rectangular loop which allows horizontally laying out a plurarity of preform carrier and (b) the carrier driving means has four linear fed mechanisms which move the preform carrier positioned in each rectangular part of the preform transfer route in the direction of filling spaces of the preform transfer route and intermittently shifts the preform carriers in a constant direction.

Claim 3: A preform cooler as claimed in claim 1, wherein (a) the preform carrier is provided with a rotary table which is formed for each area determined by rotating the cylindrical protrusions at a given angle and (b) the carrier driving means has a rotary feed mechanism which shifts the angular positions of the cylindrical protrusions by intermittently rotating the rotary table in a constant direction.

Claim 4: A preform cooler as claimed in claims 1 through 3, wherein the position for sending cooling air to the cylindrical protrusions via the airflow path is located in an area avoiding the delivery area of the preform transfer route.

Claim 5: A preform cooler as claimed in claims 1 through 4, characterized by having (a) a cover which covers an area avoiding the upper positions of the supply area and the

delivery area throughout the preform transfer route and (b) an air diffusing means for cooling the preforms from their outer walls by sending cooling air within this cover.

Detailed Description of the Invention

Industrial Field of the Invention: This invention relates to a preform cooler which cools bottomed cylindrical preforms used for one-axial or two-axial stretch blow molding after injection molding.

Prior Art: In the production process for bottles of polyethylene terephthalate by two-axial stretch blow molding, bottomed cylindrical preforms are produced by injection molding and then processed by two-axial stretch blow molding. In the injection molding process for producing preforms, preforms are cooled and solidified in a mold and then taken out of the mold.

Problems to Be Resolved by the Invention: In the conventional injection molding method wherein preforms are completely cooled in the mold, however, if the cooling time is extended in the molding cycle consisting of injection, cooling, opening, and takeout, the time required for the whole molding cycle is also extended resulting in a marked decrease in productivity.

Considering the above problem, this invention aims at cooling the preforms with another equipment after they have been taken out of the mold. For this purpose, the invention is intended to provide a preform cooler which is simply designed and yet has high cooling efficiency.

Means of Solving the Problems: The preform cooler of this invention comprises (a) preform carriers which are provided with cylindrical protrusions to receive bottomed cylindrical preforms taken out of a mold for injection molding while placing them over the cylindrical protrusions, (b) a carrier driving means which drives the preform carriers to move the cylindrical protrusions from a preform supply area to a delivery area and then to the supply area again along a preform transfer route, and (c) an air diffusing means for cooling the inner walls of the preforms, which is used to send cooling air upward via an airflow path to the insides of the cylindrical protrusions moving along the preform transfer route, wherein each of the preform carriers is provided with the cylindrical protrusions in the same number as that of cavities in the

mold and each of the cylindrical protrusions is provided with a plurarity of air diffusing holes to diffuse cooling air sent to that cylindrical protrusion to the inside of each preform.

In this invention, if the preform transfer route is structured like a rectangular loop which allows horizontally laying out a plurarity of preform carriers, four linear feed mechanisms are used as a carrier driving means, which feed the preform carrier positioned in each rectangular part among a plurarity of preform carriers laid out with spaces in the preform transfer route, in the direction of filling the spaces, thereby intermittently shifting the preform carriers in a constant direction.

In this invention, if the preform carrier is provided with a rotary table which is formed for each area determined by rotating the cylindrical protrusions at a given angle, a rotary feed mechanism which shifts the angular positions of the cylindrical protrusions by intermittently rotating the rotary table in a constant direction is used as a carrier driving means.

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In this invention, it is preferable that a leak of cooling air from cylindrical protrusions without a preform be suppressed by selecting the position for sending cooling air to the cylindrical protrusions via the airflow path, within an area avoiding the delivery area.

In this invention, it is also preferable that the preforms be cooled from their outer walls by providing a cover which covers the area avoiding the upper position of the supply and delivery areas throughout the preform transfer route, and an air diffusing means for cooling the preforms from their outer walls within this cover.

Working of the Invention: The perform cooler of this invention receives preforms taken from a mold for injection molding by placing them over cylindrical protrusions on preform carriers, and then drives the preform carriers with a carrier driving means to move the cylindrical protrusions from the supply area for preforms to the delivery area and also to the supply area again. Each protrusion is provided with a plurarity of air diffusing holes, from which cooling air is diffused inside the preform, thus cooling the preform from its inner wall. Since the preform is a bottomed cylindrical one for this reason, even a difficult-to-cool molded product can be cooled efficiently. Preforms are

received by placing them over protrusions and this structure requires no complicated retention mechanism. Each preform carrier has cylindrical protrusions formed in the number corresponding to one shot of a mold, ensuring high processing capacity.

Examples: Based on the drawings, examples of this invention are described below:

Example 1: Fig. 1 is an outlined plan view of the preform cooler in this example. Fig. 2 is a longitudinal sectional .view of the preform cooler. Fig. 3(s) is a longitudinal section taken on line i-i' in Fig. 1. Fig. 3(b) is an illustration showing cylindrical protrusions which are used to retain preforms.

In Figs. 1 and 2, a preform cooler 10 is located in a position lateral to the injection molding machine 1 and designed to be fed at a time with the preforms P of one shot taken out of a mold 2 by a preform transfer robot (indicated with the arrow A).

The preform cooler 10 is provided with a guide 12 which horizontally extends on the upper surface of a base 11. The upper surface of the guide 12 constitutes a preform transfer route 13. When the preforms P are transferred within the preform cooler 10, the metal, resin, or wooden preform carriers 14 of a rectangular shape are used in this example. As shown in Fig. 3(a), a guide groove 122 into which both ends of the preform carrier 14 are fit is formed on the inner surface of the guide 12 so that the preform 14 horizontally slides without falling off.

Also referring to Figs. 1 and 2, in this example, a preform transfer route 13 has a position adjacent to an injecting molding machine 1, in which the supply area IN for the preforms P is located. A preform delivery area OUT is located in the region going around from a supply area IN through the arrows X1, Y1, and X2, and then returning to a position adjacent to the supply area IN. In a position lateral to the delivery area OUT, the robot (indicated with the arrow B) for taking out the preforms is located.

The preform transfer route 13 is formed like a rectangular loop which allows aligning two rows of a plurarity of preform carriers 14. Fig. 1 shows a state wherein 12 preform carriers 14 are laid out along the preform transfer route 13 so that the first and third rectangular parts 131 and 133 among the rectangular parts 131 through 134 of the preform transfer route 13 come to the spaces Q1 and Q2 for the preform carriers 14. In the rectangular parts 131 through 134 of the preform transfer route 13, the

respective first through fourth pusher mechanisms 151 through 154 (linear feed mechanisms for carrier driving means) are provided. The first pusher mechanism 151 is located so as to feed out the preform carrier 14 positioned in the first rectangular part 131 in the direction of the arrow X1. The second pusher mechanism 152 is located so as to feed out the preform carrier 14 positioned in the second rectangular part 132 in the direction of the arrow Y1. The third pusher mechanism 153 is located so as to feed out the perform carrier 14 positioned in the third rectangular part 133 in the direction of the arrow X2. The fourth pusher mechanism 154 is located so as to feed out the preform carrier 14 positioned in the fourth rectangular part 134 in the direction of the arrow Y2. More specifically, the first through fourth pusher mechanisms 151 through 154 are designed to feed the preform carriers 14 positioned in the first through fourth rectangular parts 131 through 134 in the direction of filling the spaces Q1 and Q2, thereby intermittently moving the preform carriers 14 in a constant direction (counterclockwise in Fig. 1).

The preform carrier 14 carries preforms P while supporting them as described below. As illustrated in Fig. 3(a), the preform carrier 14 is configured with a plate 145 which slides in the guide groove 122 of the guide 12 and eight protrusions made of metal or heat-resistant resin, which protrude upward from the plate 145. The preform carrier 14 receives preforms P by covering each of these protrusions with a preform P and is able to carry the preforms P in this state. In this example, the mold 12 has each four cavities formed in two rows. Eight preforms P molded by one shot are taken out at a time and then fed to the preform cooler 10. One preform carrier 14 has two rows of each four cylindrical protrusions 146 formed in the positions corresponding to those of the cavities in the mold 2, thereby being able to receive the preforms P equivalent to one shot of the mold 12 at a time.

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On the left and right sides of the base 11, two blowers 16 (air diffusing means for cooling the inner walls of the preforms) are provided. In a position below the preform transfer route, a bottom cover 17 is provided so as to cover the bottom of the preform transfer route. The blowers 16 are used to send cooling water between the bottom 17 and the preform transfer route 13. When the preform carrier 14 passes through the preform transfer route 13, the former blocks the latter. Thus, an airflow path 161 is created between a bottom 141 of the perform carrier 14 and the bottom cover 17. In

the region from the delivery area OUT to the supply area IN, it would be useless for the cylindrical protrusions passing through that region to diffuse cooling air. In this region, therefore, the cylindrical protrusions 146 are designed to stop diffusing cooling air, thereby eliminating the unnecessary diffusion of cooling air. In this case, since the amount of cooling air sent to the inside of each preform P can be secured sufficiently, the cooling capacity is improved.

In this example, the cylindrical protrusions 146 on the preform carrier 14 are harrow and have a plurality of air diffusing holes formed on their lateral sides. As illustrated in Fig. 3(b), the leading end of the cylindrical protrusion 146 has an air diffusing hole 148 from which slits are extended radially. Therefore, the cooling air sent by the blower 16 enters an inside 149 of the cylindrical protrusion 146 through the airflow path 161 as indicated with the arrow C1, and then diffused from the air diffusing holes 147 and 148 as indicated with the arrow C2. The air diffused between the cylindrical protrusion 146 and the preform P is released from a gap 145 formed between the lower end of the preform P and the preform carrier 14. This means that even if the length of preform P is changed, the cylindrical protrusion may be covered with the preform P as it is.

Also in this example, as illustrated in Fig. 2 and Fig. 3(a), the region of the upper surface of the preform transfer route 13 other than the supply area IN and the delivery area OUT is covered as the cooling area COOL with a top cover 18. A leading end 181 of the top cover 18 is bent downward, thus creating a cooling corner 19 on the upper surface of the preform transfer route 13. On the upper surface of the top cover 18, three blowers 20 (air diffusing means for the outer walls of preforms) are installed to send cooling air to the inside of the cooling corner 19 as indicated with the arrow D. The cooling air sent to the cooling corner 19 is released to the outside from the bottom of a leading end 181.

Referring to Figs. 1 through 3, the operation of the preform cooler 10 which is configured as stated above is described here.

In the state shown in Fig. 1, eight preforms P which have been taken out of the injection molding machine 1 and the mold 2 by the preform transfer robot (indicated with the arrow A) are fed at a time to the supply area IN of the preform cooler, wherein the cylindrical protrusions 146 on the preform carrier 14 are covered with the preforms

P. Subsequently, the injection molding machine 1 starts the next cycle of injection molding.

In this state, on the preform cooler 10, the first and third rectangular parts 131 and 133 of the preform transfer route 13 become the spaces Q1 and Q2 for preform carriers 14. Now all of the first through fourth pusher mechanisms 151 through 154 have their rods retreated.

When the second and fourth pusher mechanisms 152 and 154 in the above state are actuated to extend their rods, the preform carrier 1 positioned in the second rectangular part is moved to the third rectangular part 133 so as to fill the space Q1. Similarly, the preform carrier 14 positioned in the fourth rectangular part 134 is also moved to the first rectangular part 131 so as to fill the space Q2. As a result, the second and fourth rectangular parts 132 and 134 become the spaces for preform carriers. Subsequently, the first and third pusher mechanisms 151 and 153 are actuated to move the preform carrier 14 positioned in the third rectangular part 133 in the direction of the arrow X2 to the fourth rectangular part 134. Similarly, the preform carrier 14 positioned in the first rectangular part 13 is moved in the direction of the arrow X1 to the second rectangular part 132.

After injection molding in the mold 2 has been finished, preforms P are fed to the supply area IN from the mold 2 and then the above process is repeated. As a result, the preform carriers 14 are shifted one by one in the directions of the arrows X1, Y1, X2, and Y2. Thus, the preforms P are transferred from the supply area IN to the delivery area OUT.

During this process, the preforms P are cooled. As illustrated in Fig. 3(a), below the preform transfer route, the cooling water sent by the blower 16 enters the inside of each cylindrical protrusion 146 on the preform carrier 14 through the airflow path 161 and then are diffused from the air diffusing holes 147 and 148. Thus, the preform P is cooled from its inner wall. Above the preform transfer route 13, the cooling air sent by the blower 16 goes into the cooling corner 19, thus cooling the preforms P from their outer walls. The area for supplying cooling air is defined by the top cover 18 to increase the velocity of the cooling air sent to the outer walls of the preforms P, thereby ensuring high cooling capacity.

The preforms P on the preform carrier 14 are sufficiently cooled, carried over in that state in the directions of the arrows X1, Y1, and X2, and then reach the delivery area OUT. In the delivery area OUT, the set of eight preforms P are delivered out at a time by the preform takeout robot as indicated with the arrow B. The perform carrier 14 without performs P is moved forward in the directions of the arrows Y2 and X1 and then returns to the supply area IN.

As stated above, according to the preform cooler in this example, since the preforms are sufficiently cooled from both their inner and outer walls, they do not need to be cooled and solidified completely inside the mold 2. Therefore, the cooling time can be markedly shortened in the injection molding process of injection, cooling, opening and takeout, and the required time for the whole cycle can also be shortened. The productivity of preforms P is improved accordingly. In addition, even the inner walls of preforms P which are difficult to cool can be efficiently cooled because the bottomed cylindrical protrusions 146 are covered with preforms P and cooling air is sent to the gap between the preform P and the cylindrical protrusion 146. Moreover, the dimensional accuracy of the preform P is high. Since preforms P are received by covering cylindrical protrusions with them, no complicated retention mechanism for preforms P is required.

A set of eight preforms P which have been molded by one shot is carried at a time by a single preform carrier 14 to ensure high processing capacity. This feed operation occurs in association with the molding operation of the injecting molding machine 1, thus allowing easy control of the first through fourth pusher mechanisms 151 through 154. To drive the preform carriers 14, the pusher mechanisms are used without configuring an endless track with a chain, sprockets, and others. This facilitates positioning the preform carriers 14 at high accuracy.

Example 2: Fig 4 is an outlined plan view of the preform cooler in this example. Fig. 5 is a longitudinal sectional view of said preform cooler. In this example, the constructions of the injection molding machine, mold, and others are the same as those in example 1. Therefore, the corresponding parts are assigned the same symbols and the explanations of those parts are omitted.

Figs. 4 and 5, a preform cooler 30 in this example is also located in a position lateral to an injection molding machine 1. Eight preforms P molded in a mold 2 for injection molding are fed at a time by a preform transfer robot 50, which is provided with a preform chuck 51 to take out the eight preforms P at a time from the mold 2 and retain them upside down, an elevation mechanism 52 for the preform check 51, and a horizontal movement mechanism 53 for the preform check 51.

In the preform cooler 30, a rotary table 32 (preform carrier) is structured on the upper surface of a base 31. The top of the rotary table 32 constitutes a preform transfer route 33. More specifically, the central part of the rotary table 32 is linked to a rotating output shaft M1 of a drive motor M (carrier driving means and rotary feed mechanism) fixed to the base 31, and the rotary table 32 is intermittently rotated at an angle of 45 degrees each as the rotating output shaft M1 intermittently rotates at an angle of 45 degrees. On the top of the rotary table 32, eight preform holding areas 34 are formed at intervals of 45 degrees to receive the preforms P supplied. Two rows of eight cylindrical protrusions 346 extend upward from each preform holding area 34. As illustrated in Fig. 6, the preforms P are transferred with the cylindrical protrusions covered with them. The positions of the cylindrical protrusions 346 correspond to those of the cavities in the mold 2. Therefore, eight preforms P can be taken out of the mold 2 and then placed over the cylindrical protrusions 346. Each of the cylindrical protrusions 346 is bolted into the rotary table 32 via a block 348, and its inside leads to a through holes 362 formed in the rotary table 32.

Referring to Figs. 4 and 5 again, a supply area IN is located in the position closest to the injection molding machine throughout a preform transfer route 33. A delivery area OUT is located forming an angle of 45 degrees with the right side of Fig. 4 from the supply area IN. Laid out around the delivery area OUT are a preform takeout robot 60 and a bucket 61 to accommodate the preforms P taken out by this robot. The preform takeout robot 60 is provided with a preform chuck 61 to take out eight preforms P at a time from the cylindrical protrusions 346 and retain them, an elevation mechanism 62 for the preform chuck 61, and a horizontal movement mechanism 63 for the preform chuck 61.

The region other than the delivery area OUT throughout the preform transfer route 33 is used as a cooling area COOL, wherein a space below the rotary table 32 constitutes an airflow path 361 partitioned by a cover 376 which is internally attached to a base 31

and by a motor cover 372. The cooling air sent by a blower 36 (air diffusing means for cooling the inner walls of preforms) fixed to the outside of the base 31 goes to the inside of the airflow path 361.

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As illustrated in Fig. 7 for a traverse section taken on line ii-ii' in Fig. 5, a cover 376 has a concave part 377 which is equivalent to the delivery area OUT, so that no cooling air reaches any position below the delivery area OUT.

As illustrated in Fig. 8, in the cooling area COOL, the region other than the supply area IN and the delivery area OUT on the upper surface of the preform transfer route 33 is covered with a top cover 38. A leading end 381 of the top cover 38 is bent downward to create a cooling corner 39 on the upper surface of the preform transfer route 33. On the lateral side of the top cover 28, a blower 40 (air diffusing means for cooling the outer walls of preforms) is installed to send cooling air to the inside of the cooling corner 38 as indicated with the arrow D. The cooling air sent to the cooling corner 39 is released to the outside after passing below the leading end 381 of the top cover 38.

The operation of the preform cooler 30 configured as described above is now explained referring to Figs. 4 and 8.

In Fig. 4, eight preforms P which have been taken out of the injection molding machine 1 and the mold 2 by the perform transfer robot 50 are fed at a time to the supply area IN of the preform cooler 30 and then placed over protrusions 346. Subsequently, the injection molding machine 1 starts the next cycle of injection molding. At this time, the preform takeout robot 60 has already removed the preforms P from the cylindrical protrusions 346 in the delivery area OUT and then delivered them out to the bucket 61.

Starting in this state, a drive motor M rotates the rotary table 32 within an angular range of 45 degrees in the direction of the arrow E. As a result, the preforms P are fed by the angle of 45 degrees in the direction of the arrow E. From the delivery area OUT, the cylindrical protrusions 346 without preforms P come to the supply area IN. Subsequently, after injection molding inside the mold 2 has been finished, preforms P

are fed from the mold 2 to the supply area IN and then the above operation is repeated. As a result, the preforms P are transferred from the supply area IN to the delivery area OUT.

During this process, the preforms P are cooled in the cooling area COOL. More specifically, as illustrated in Fig. 8, the cooling air sent by the blower 36 below the preform transfer route 33 enters the cylindrical protrusions 349 through an airflow path 361 and a through hole 362, and then is diffused from air diffusing holes 347. Thus, the preforms P are cooled from their inner walls. However, the airflow path 361 is not formed in a position corresponding to the deliver area OUT, and therefore the cylindrical protrusions which pass through the airflow path 361 do not diffuse cooling air. The reason is that the preforms P transferred to the delivery area OUT are already cooled and that it would be useless to diffuse cooling water from the cylindrical protrusions without preforms P. In this example, therefore, no unnecessary cooling air is diffused. This ensures high cooling capacity by securing a sufficient amount of cooling air to be sent to the inside of each preform P. Above the preform transfer route 33, the cooling air sent by the blower 40 is directed toward the cooling corner 39 and the preforms P are cooled from their outer walls. In this case, the cooling air supply area is defined by the top cover 38 so that the velocity of cooling air sent to the outer walls of preforms P is increased to ensure high cooling capacity.

The preforms P placed on the rotary table 32 are sufficiently cooled as they pass through the cooling area COOL, and then delivered from the delivery area OUT.

As state above, according to the preform cooler in this example, it is not necessary to completely cool and solidify the performs P in the mold 2. This allows markedly shortening the cooling time in the injection molding cycle of injection, cooling, opening, and takeout. Therefore, the same effects as in the example 1 can be expected including the improved productivity of preforms P. In the preform cooler in this example, eight preforms P molded by a single shot are received at a time ensuring high processing capacity. In addition, the rotary feed operation of the rotary table 32 is only performed intermittently in association with the molding operation of the injection molding machine 1. This facilitates positioning the cylindrical protrusions 346 at high accuracy.

Effects of the Invention: As stated above, the prefrom cooler of this invention is

characterized in that a plurality of protrusions which can receive all preforms of the number corresponding to one shot of a mold by covering each cylindrical protrusion with each preform is formed on the preform carrier and in that air diffusing holes to blow cooling air as air diffusing means are formed on each cylindrical protrusion. According to this invention, it is not necessary to completely cool and solidify the preforms in the mold. This allows shortening the required time of the molding cycle, thereby improving the productivity of preforms. The inner wall of each cylindrical protrusion can be cooled by diffusing cooling air from the air diffusing holes in the cylindrical protrusion. Therefore, cooling preforms and other molded products can be cooled efficiently. Since preforms are received by covering the cylindrical protrusions with them, no complicated retention mechanism is required. Cylindrical protrusions more than the number of cavities are formed on the preform carrier to ensure high processing capacity.

If the carrier driving means is formed using four linear feed mechanisms which intermittently deviate the preform carrier along the rectangular preform transfer route or a rotary feed mechanism which intermittently rotates a rotary table on which cylindrical protrusions are formed, it is not necessary to constitute a endless track with a chain, sprockets, and others. Therefore, the preform carrier can be positioned easily and accurately.

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Brief Description of the Drawings

Fig. 1 is an outlined plan view of the preform cooler in the example 1 of this invention.
Fig. 2 is an outlined longitudinal sectional view of the preform cooler shown in Fig. 1.
Fig. 3(a) is an outlined longitudinal section taken on line i-i' in Fig. 1 and Fig. 3(b) an illustration showing cylindrical protrusions which are used to retain preforms.
Fig. 4 is an outlined plan view of the preform cooler in the example 2 of this invention.
Fig. 5 is an outlined longitudinal sectional view of the preform cooler shown in Fig. 4.
Fig. 6 is a longitudinal sectional view of a rotary table for the preform cooler shown in Fig. 4 and cylindrical protrusions formed thereon.
Fig. 7 is an outlined transverse section taken on line ii-ii' in Fig. 5.
Fig. 8 is an outlined longitudinal section taken on line iii-iii' in Fig. 5.

Explanations of Letters or Numerals:

1. Injection molding machine

2. Mold

10, 30: Preform cooler

13, 33: Preform transfer route

14. Preform carrier

16, 36: Blower (air diffusing means for cooling the inner walls of preforms)

17, 38: Lower cover

18: Upper cover

19, 39: Cooling corner

20, 40: Blower (air diffusing means for cooling the outer walls of preforms)

32: Rotary table (preform carrier)

131, 132, 133, 134: Rectangular part of preform transfer route

146, 346: Cylindrical protrusion

147, 148, 347: Air diffusing hole

151, 152, 153, 154: Pusher mechanism (linear feed mechanism)

IN: Supply area

OUT: Delivery area

COOL: Cooling area

M: Drive motor (rotary feed mechanism)

P: Preform

Q1, Q2: Space in perform carrier

X1, Y1, X2, Y2: Feed orientation of pusher mechanism

10. Preform cooler

14. Preform carrier

Takeout robot

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10. Preform cooler

122. Preform carrier

32. Rotary table

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1. Injection molding machine
30. Preform cooler
32. Rotary table
36. Blower

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Technical Indication

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